# SUMMARY MINUTES FOR MEETING OF CONTRACTOR P E R T REPORTING PERSONNEL

8-9 JUNE 1960
14-15 JULY 1960


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NOVEMBER 1960



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From: Director, Special Projects

To: Distribution

Subject: Meeting of Contractor PERT Reporting Personnel, Aerojet-General, Sacramento, California, 14 and 15 July 1960

1. Second meeting of Contractor PERT Reporting Personnel was held at Aerojet-General, Sacramento, California. This meeting was held for improving PERT communication between Special Projects Office and SP contractor reporting personnel on the Pacific Coast and in the Midwest.

2. Through active interchange of ideas among SP contractor reporting personnel, Special Projects Office seeks to promote better working knowledge and continuous improvement in the SP-Contractor program evaluation and reporting techniques.

K. M. TEBO
By direction

**ROSTER**
**for**
**Meeting of Contractor PERT Reporting Personnel**
**Aerojet-General, Sacramento, California**
**14 and 15 July 1960**

| | |
|---|---|
| Aerojet-General Corporation | R. D. Archibald, R. E. Meyer, P. P. Datner, S. A. Chappell, R. E. Steinmuller, H. S. Phelps, W. F. Harper, J. D. Poulsen, Karl Schmid, J. D. Barney (Azusa, Calif.) |
| Hughes Aircraft | G. K. Rich, M. B. Osband |
| Honeywell (ORD) | J. V. Wilson |
| | J. W. Bonquet |
| Honeywell | P. P. Savage |
| Control Data | H. R. Lindquist |
| Nortronics | L. A. Guolo |
| Westinghouse | R. R. Marshall |
| | E. O. Dick |
| RINSMAT | R. N. Williams |
| Librascope Division of GPI | J. Ciochetto |
| | A. J. Smith, Jr. |
| Mare Island Naval Station | G. Van Dolson |
| Naval Weapons Laboratory | R. N. Learn |
| Special Projects Office | T. Enzor |
| | Y. Nakayama |
| Hercules Powder Company | W. H. Roberson |
| | W. B. Patterson |
| Lockheed | W. P. Gruner, R. T. Henry, J. A. Koch, C. W. Jenkins, Kay Sackrider, J. D. Blitch |
| Autonetics | W. E. Nelson |
| Western Electric Company | T. B. Ridgeway |
| | J. L. Colley |
| SPL | J. Lee |

## SUMMARY MINUTES
## for
## Meeting of Contractor PERT Reporting Personnel
## Aerojet-General, Sacramento, California
## 14 and 15 July 1960

Mr. Datner, Aerojet, welcomed the participants for the host contractor. Mr. Yukio Nakayama, Sp121, was introduced as the chairman for the meeting. Mr. Nakayama announced the purpose of the meeting as follows:

1. To provide a workshop for exchange of ideas among contractors for improvement in the mechanics of the PERT reporting system.

2. To discuss compatibility between contractor and NORC computer program where contractors are providing or are planning to provide computer outputs and analysis to SP and punched cards directly to Dahlgren for SP processing.

It was emphasized by the chairman that policy questions on PERT should be held for the PERT Task Group Meeting which is scheduled for August 16 and 17 at LMSD, Sunnyvale.

It was announced that group discussions would be held in the afternoon and requested that each group be ready to discuss findings and recommendations to the entire group the following morning:

The Chairman distributed to the attendees copies of the following:

1. Summary Minutes for Meeting of Contractor PERT Reporting Personnel, General Electric, Pittsfield, Massachusetts, 8 and 9 June 1960.

2. Technical Memorandum, Mechanization of the PERT System on NORC, U. S. Naval Weapons Laboratory, Dahlgren, Virginia.

3. PERT Transaction Codes (See Appendix).

The chairman then introduced Mr. Tom Enzor, Sp123, to lead the discussion on the *Fundamentals of PERT*. This was followed by a discussion led by Mr. Bob Learn, NWL, Dahlgren, Virginia, on the *NORC Computer Operations and PERT Reporting*.

Mr. Thomas H. Enzor presented the following data on *The Fundamentals of PERT:*

I. Vugraphs:

1. Basic Requirements for Applying PERT
2. Network Components
3. PERT Events—Definition
4. PERT Activities—Definition
5. Estimating the Time Distribution
6. Activity Time Estimates and Mean Activity Time
7. Probability Calculation
8. The PERT Report Form
9. The Computer Output Sheet

II. Following the showing of the Vugraphs above, Mr. Enzor developed the following items:

1. *The Fundamental Requirements of PERT.* The fundamental requirements of PERT are:

A. The PERT Network/Flow Chart
B. Activity Definitions
C. Elapsed Time Estimates

2. *The Base Line.* Although we *think* we understand all of the rules governing the application of the base line because of its relative ease of portrayal when developing the network, this is not always the case. Accordingly, we need to review the following requirements of *Base Line Application:*

A. The Base Line must be *numbered.*
B. The Base Line must be *dated*—The date assigned may be in the past or present. (It is *not* to be in the future for NORC application.)
C. The base line should *not* have over 32 activities leading from it without adding a new base line number for each successive group of 32 activities. (NORC rule) *When* this is done the number of activities running from the base line is limitless.
D. Use "Code 7" to establish the base line event (NORC).
E. The most appropriate and desired way of graphically developing the base line is "a top to bottom of the sheet straight line."

3. *Events:*

A. Events are purely points in time. They are *not* to be associated with the performance of activities. Since they are points in time, event titles must be titled to relate to points in time; i.e., start complete, release, ship, etc.
B. Other requirements are that events must be numbered and must be stated in clear, concise language not to exceed 48 spaces.
C. In transmitting event titles to the Special Projects Office (Sp12), use the prescribed form entitled "PERT Nomenclature Transmittal." (Sp12 furnished)
D. Use "Code A" when *adding* new event titles or *correcting* event titles transmitted by "the PERT Nomenclature Transmittal."
E. Events that are designated as "common" or integration" events (i.e., found on two or more networks) should be clearly identified.
F. Provide schedule dates for big events on the network. As a minimum provide a schedule date for accomplishment of each end objective.

4. *Activity Definitions:*

A. The submission of activity definitions along with networks requires re-emphasis. They are important to the PERT analysis process and assist in the understanding of the network.

B. Activity definitions are particularly important to persons estimating.

C. If the tasks identified by activity definitions change, the activity definitions should be correspondingly revised with copy to Sp12. No particular form is prescribed either for establishment or revision of activity definitions.

5. *Estimating of Elapsed Times:*

A. Time to accomplish a task can be expressed in terms of likelihood rather than positive assurance. Likelihood, in turn, can be expressed in terms of statistical probability and distribution curves.

B. At least three time estimates are needed to develop a distribution curve and to complete probability—two estimates to represent extremes on either side of a mode and one to represent this mode. These estimates are referred to in PERT terminology as:

(1) Optimistic (time) estimate
(2) Most likely (time) estimate
(3) Pessimistic (time) estimate

C. From the three time estimates two things are derived in PERT technology:

(1) A statistical *expected time* using the formula: $\frac{a + 4m + b}{6}$

(2) A statistical *Variance* using the formula: $\sigma_{t_e}{}^2 = \frac{(b-a)^2}{6}$

D. All time estimates are to be based on Elapsed Time, i.e., days, weeks, months, etc., and are to be reported in terms of weeks or tenths of weeks.

E. Estimates are also to be based upon *planned* resources. Planning usually calls for expending resourses at a constant rate, i.e., a 1 shift 8 hour day or 2 shift—eight hour day, etc. Whatever the plans are when developing or revising a network, use these plans to estimate or re-estimate.

F. Estimates are generally best when they are obtained from the man who has the most experience in the tasks to be performed and is therefore most knowledgeable of the probabilities. Usually this man performs the work.

G. Schedules and calendars should *not* be used to estimate.

6. *Re-Estimating:*

A. Re-estimates follow the submission of original estimates as, for example:

(1) Plans are revised
(2) Technical difficulties arise
(3) Technical break-throughs are experienced
(4) Overtime is authorized
(5) Personnel are added or reduced, etc.

B. It is *very* important to indicate the *reasons* for re-estimates on the regular PERT reporting form. This is not being done in every case, nor are explanations adequate, as a rule.

C. The reporting codes to be used during reporting of estimates and re-estimates are explained in the handout titled "PERT transaction codes." Handout prepared for this conference by Dahlgren.

7. *Developing the PERT Flow Chart/Network:*

A. Experience indicates that it is advisable to start with an end objective and work backward in developing a network.

B. PERT networks are to be developed on the basis of *Plans*.

C. Constraints are best identified after the basic flow has been established.

D. Networks are to be validated by the appropriate official and dated. All succeeding networks should likewise be validated and dated.

8. *Network Reproduction, Size, Etc.:*

A. Reproduced copies of networks should be readable.

B. Every effort should be exerted to control the size and number of sheets on which networks are printed. Remember that they must be "handled." Large size sheets and large numbers of sheets are difficult to "handle."

C. It is *not* necessary to publish a revised network with every minor change.

9. *Security Classification:* The security classification of all PERT data (networks, computer runs, etc.) should be carefully considered. Over-classification could cause undue delays.

10. *PERT Analysis:*

A. There is no set rule as to how PERT can be used for analysis. The "how" is as broad as the imagination, ingenuity and ambition of the analyzer.

B. "When" an analysis should be made follows the general rule "as soon as possible after receipt of data."

C. *Where*:

(1) Sp 12 is using the contractor reports and computer outputs to prepare analysis and distribution to appropriate organizations and top management of SP, to government-contractor liaison organizations, and the contractor.

(2) The contractors, hopefully, are making effective use of their reports and computer outlooks, Sp12 analysis, etc., to prepare presentations to their management.

11. *The Computer (PERT) Run:*

A. Arranges a large quantity of data in logical divisions of interest (critical-slack paths, etc.) and also sequences information in logical order (event nos.—expected date sorts) for ready reference.

B. This information can be additionally "tailored" to present a variety of situations; trends, etc.

C. This information can be used to draw conclusions as to courses and effects and most of all serve as a basis for management decisions.

D. PERT computer runs can also, of course, be used as a tool for measurement of progress.

Mr. Robert Learn, NWL, Dahlgren, Virginia, presented the following data on *NORC Computer Operation and PERT Reporting:*

I. REPORT OF TIME INTERVAL ESTIMATES AND PROGRESS. The "flow plan" and the associated "elapsed time estimates" of an FBM subsystem are subject to frequent change. The contractor informs the Special Projects Office (Sp12) of these changes by submitting a "Report of Time Interval Estimates and Progress".

II. TRANSACTION CODES. In order that these changes may be automatically handled by the NORC programs, a system of transaction (change) codes was established. In general these transaction codes have the following functions; for a more detailed explanation see Appendix.

A. *Transaction Code 1.* Code 1 indicates that the transaction data contains a new activity which is not in the file. If an original file is being set up, this transaction would have to be constructed as an event message. If an existent file is being updated, this transaction would add a new activity to the indicated existent predecessor and successor events or construct and insert a new event message if there are no existent predecessor and/or successor events. A "schedule date" and a "report code" may be added to the successor event message with this code.

B. *Transaction Code 2.* Transaction code 2 indicates that the transaction data contains a new expected time and variance as a result of a re-estimate of the elapsed time for an activity. The new data is used to replace the old in the indicated predecessor and successor event messages. The schedule date, if any, is inserted in the successor event message.

C. *Transaction Code 3.* Transaction code 3 indicates that the transaction data represents an activity that has been completed and its completion date. The transaction removes the activity from the the indicated events and in the case of the successor events, adds the completion date to the event message. If there is no completion date, the transaction rejected.

D. *Transaction Code 4.* Transaction code 4 indicates to the NORC that the transaction data contains a schedule date to be inserted in the successor event message. If the schedule date on the transaction is zero, then the schedule date area in the successor event message is made zero. This code allows one to insert, change, or delete a schedule date.

E. *Transaction Code 5.* Transaction code 5 indicates that the transaction data contains an activity that is to be deleted from the indicated predecessor and successor event messages.

F. *Transaction Code 6.* Transaction code 6 indicates that the transaction contains a short path flag for insertion in the successor event message. If the short path flag is zero, it will erase the short path flag in the successor event message. If it is a "1" or a "2", it is inserted in the successor event message, replacing any short path flag that may already be there. If it is "3" or greater, it is changed to a "1" and inserted as stated above.

G. *Transaction Code 7.* Transaction code 7 indicates that a completion date is to be added to the successor event message. Transaction code 7 is similar to code 3 but differs in that it does not remove an activity from either the predecessor or successor event messages. If the completion date on the transaction is zero, then the completion date area of the successor event message is made zero.

H. *Transaction Code 8.* Transaction code 8 indicates that the transaction data contains a report code to be added to the successor event message. If the report code shown is zero, then the report code area in the successor event message is made zero. This code allows one to insert, change, or delete a report code.

III. PROCEDURE FOR REPORTING CHANGES. The above mentioned "Report of Time Interval Estimates and Progress" is used by most contractors to report changes to their subsystems. They are sent to Sp12 where they are reviewed and the change data recorded on the flow plan. Another method of reporting changes, presently used by one contractor, is to send the change data, in the same form described above, directly to NWL, Dahlgren via TWX. The data from the resulting punched paper tape is transcribed to NORC magnetic tape and used for input to the computer. This method has proved quite satisfactory and helps to reduce the time required for the reporting cycle.

IV. COMPUTER PROCESSING. After the changes submitted by the contractor have been reviewed by Sp12, they are sent to NWL, Dahlgren for processing. These change data are key punched and key verified into IBM punched cards. Computer run 01 performs the conversion of the punched card data to NORC magnetic tape at the rate of 100 cards per minute. Computer run 02 has three functions as

follows: (1) to compute the expected time and its associated variance from the three elapsed time estimates for each activity, (2) to generate two output tapes that can be used to up-date the predecessors and successors of each applicable event, and, (3) to validate the transaction data. Computer runs 03, 04, and 05 sort and merge the transaction data so that each predecessor transaction has the necessary data for updating the successor activity specified by the predecessor code, and each successor transaction has the necessary data for updating the predecessor activity specified by the successor code. Computer run 06 basically performs two functions, it will establish an original event file or update an existent event file by changing, deleting, or adding event data. Computer run 07 orders the event file tape in such a way that the computations can be accomplished in a systematic and efficient manner. Computer run 08 computes and adds to each event message in the event file: the earliest (expected) time, its associated variance, the latest allowable time and its associated variance, slack, and the probability of meeting a schedule date. There are three options for computing the latest allowable time. The computation may be based on any arbitrary date, it may be based on the earliest time for all end events or it may be based on the schedule date for all end events. Computer runs 09-18 edit, sort, and associate the event output data with the descriptive titles for printing on a high speed microfilm camera. The film is developed and then hard copies prepared at a rate of twenty five pages per minute. A description of the regular event output as well as the graphic output can be found in the Technical Memorandum "Mechanization of the PERT System on NORC" (No. K-19/59).

V. EXPERIMENTS FOR IMPROVING COMMUNICATION. NWL, Dahlgren is presently experimenting with (1) a procedure for sending PERT outputs directly to the contractor via TWX, (2) additional graphic reports, and (3) outputs that are activity oriented.

In concluding the morning session, the chairman passed out questions on PERT theory, PERT Report form and computer output sheets and briefly reviewed the answers as a starting point for the afternoon discussion groups.

## SUMMARY MINUTES FOR SECOND SESSION OF GENERAL GROUP ON 15 JULY 1960

Findings and recommendations of each discussion group were placed before the general group meeting by the discussion group chairman at the morning session of 15 July.

Recommendations and comments of each discussion group which are similar to those discussed at GE, Pittsfield Meeting have been omitted since copies of the GE meeting were distributed at the meeting.

GROUP I.

RECOMMENDATION 1. That any agency when reproducing the PERT input data forms locally also include the detailed instructions on the back of the form.

COMMENT. Basic instructions on how to fill out the form is simply explained on the back of the reporting form. Many misunderstandings could be clarified if the users of the report form are aware of of the instruction.

RECOMMENDATION 2. That PERT personnel, in obtaining up-dating data from cognizant project personnel, utilize a form similar to that in use at Control Data in recording the information for back-up use in future dealings.

COMMENT. There is no set form to be used by Contractor PERT personnel in follow-up of detailed progress, but Control Data procedure is a good one which can be used by other contractors.

RECOMMENDATION 3. That every effort be expended within each company to tie together and cross-reference PERT events and activities with other reports such as the monthly technical progress reports, and vice versa.

COMMENT. Control Data reported that they are already providing in their monthly technical progress reports cross reference to PERT events and activities to SP. Aerojet-General reported that PERT plans are being proposed for inclusion in their Development Plan. Special Projects Office encourages contractors to provide a common basis for technical and program plans and progress reports. Objective is eventually to consolidate technical and program plans and reports wherever this is feasible.

CONCLUSION 1. That the proper definition of activities is of extreme importance, especially with relation to obtaining accurate time estimates.

COMMENT. Although definition of activities is very important, in an R&D program preciseness of definition is not always possible. This should be recognized in developing activity definitions in order not to delay the establishment of the PERT operations. Through PERT operations, problem areas which are hazy in definition can be spotlighted and proper action can be taken to define the problem.

CONCLUSION 2. That it is desirable for the contractor to prepare and submit his own analysis of the PERT results at the time of submission spotlighting problem areas and if possible describing corrective actions which have been taken.

COMMENT. Most effective Management analysis of PERT results can be provided by the contractors. Misunderstanding in the interpretation of the PERT results can be avoided if such an analysis can be provided to SP by the contractors. The major objective of the SP PERT decentralization

plan is to make available useful and timely contractor management analysis of PERT results as a basis for overall FBM Weapons System program evaluation by the Special Projects Office.

CONCLUSION 3. Three time estimates serve valuable purposes in defining the degree of uncertainty surrounding research and development activities.

COMMENT. In addition to strictly research and development activities, application of the three time estimates to areas where full production experience has not yet been established should be explored. For example, Aerojet-General is using three time estimates in the A1 Propulsion Report. A common process plan is established for each first and second stage motors. For each activity in the process plan optimistic, most likely, and pessimistic time estimates are established as follows:

1. Optimistic - best experience over the last 12 months period.
2. Most likely - average experience for the last quarter.
3. Pessimistic - worst experience over the last 12 months period.

In arriving at the time estimate, time experiences which are considered odd balls are not included in the calculation.

Aerojet-General's A1 Report consists of expected date of delivery with probability of meeting scheduled date for each first and second stage motors.

GROUP II.

RECOMMENDATION 1. In future meetings each contractor should present examples of graphic reports used for presenting PERT outlook.

COMMENT. This is an excellent idea and will be made a part of the agenda for future meetings.

RECOMMENDATION 2. Special Projects Office should provide an overall FBM Weapons System PERT network as a basis for tie-in of contractor component network.

COMMENT. The overall FBM Weapons System PERT network is planned for presentation at the next PERT Coordination Task Group Meeting at LMSD.

RECOMMENDATION 3. PERT networks should be sufficiently detailed to permit adequate program progress analysis.

COMMENT. The extent of detail of the PERT network will differ with level of use. If PERT is to be used as an internal contractor scheduling tool, considerable detail may be required. At the Special Projects Office level, sufficient detail is defined as detail to the extent of providing sensitivity to program progress evaluation. As a rule of thumb, this means events at four to six week intervals on the PERT flow plan.

RECOMMENDATION 4. SP monitor compilation of PERT bibliography.

COMMENT. SP will compile PERT bibliography for circulation among SP contractors.

RECOMMENDATION 5. Elapsed time be reduced for the interval from the time of contractor submission of PERT reports to receipt of outputs.

COMMENT. Computer decentralization plan proposed by Special Projects Office was for the purpose of meeting this requirement. We are still fully exploring this plan. In the meantime, we have instituted TWX reporting directly to Dahlgren in the case of MIT. We are experimenting with TWX reporting for both inputs and outputs.

GROUP III.

CONCLUSION 1. Glossary of event terminology be made to guide internal contractor reporting.

COMMENT. LMSD stated that copies of LMSD effort in compiling such a glossary will be made available to other contractors at the PERT Coordination Task Group Meeting on 16 and 17 August 1960.

CONCLUSION 2. When making PERT reports, events downstream should be evaluated as well as those falling within the cut-off date.

COMMENT. From the standpoint of SP program evaluation, we are concerned with the end objective event of the contractor network which is usually delivery of a hardware. The assessment of the impact of current problems on the end objective event and action being taken by the contractor or required of SP is desired in the contractor analysis.

CONCLUSION 3. Considerable changes and revamping of the flow diagram results from flow plan construction started on a crash basis and the lack of understanding of PERT terminology.

COMMENT. It would appear that reasons for revamping of the flow plan are due not so much from program changes but the lack of definition of program plans in accordance with PERT procedure. This is evidenced by the stabilization of the flow plan after the contractor fully understands the PERT procedure.

## SUMMARY REPORT OF GROUP ONE

**R. Archibald, AGC, Chairman**

RECOMMENDATIONS

1. That the type of input data be identified in the Remarks Column as well as by the proper code until the contractor is completely familiar with the coding technique.

2. That any agency when reproducing the PERT input data forms locally also include the detailed instructions on the back of the form.

3. That the input data form be revised as soon as possible by SP to add instructions for Code 7 and to delete "for office use only".

4. That PERT personnel, in obtaining up-dating data from cognizant project personnel, utilize a form similar to that in use at Control Data (see attachment) in recording the information for back-up use in future dealings.

5. That every effort be expended within each company to tie together and cross-reference PERT events and activities with other reports such as the monthly technical progress reports, and vice-versa.

6. That variance be printed out on the computer outputs to aid in the evaluation of the results (being done by NORC, not by AGC).

CONCLUSIONS

1. That the proper definition of activities is of extreme importance, especially with relation to obtaining accurate time estimates.

2. That time estimates must be based on the contractor's planned allocation of resources, which may or may not be a standard 40-hour week.

3. That the best way to improve the time estimates and amount and accuracy of detail in a PERT program is to provide useful and stimulating PERT feedback data to the person responsible for the activity who is providing the original data.

4. That it is desirable for the contractor to prepare and submit his own analysis of the PERT results at the time of submission, spot-lighting problem areas and if possible describing corrective actions which have been taken.

## GENERAL DISCUSSION ITEMS NOT RESULTING IN RECOMMENDATIONS OR CONCLUSIONS

1. SP reported that a comprehensive PERT training manual and indoctrination motion picture will be available for distribution in August.

2. Control Data reported that PERT is currently the sole planning tool being used in their program, and that all progress is evaluated against the PERT events and activities. Regular meetings of engineering, production, and management people are held to establish specific progress as related to the PERT network.

3. The specific usefulness of the probability output was discussed at length. One example of the direct use of probability by AGC in their POLARIS A1 report was presented. The direct relationship of this with the use of three time estimates was discussed, and there was general agreement that the three estimates serve valuable purposes in defining the degree of uncertainty surrounding Research and Development activities.

4. The use of PERT as a scheduling tool was discussed at some length. The level of confidence as expressed by probability can have considerable usefulness in such an effort. AGC mentioned that they plan to modify their program to allow variation of the probability for determining expected times, as a step in developing PERT as a scheduling tool.

5. AGC briefly described their reservations regarding the present method of determining time latest and slack time, and explained their proposed method of determining Even Slack Time by comparison of Event Expected Time to Event Scheduled Time, and further determining Activity Slack Time by comparison of Activity Expected Times with the related succeeding Event Expected Time.

## SUMMARY REPORT OF GROUP TWO

**H. S. Phelps, AGC**
**Chairman**

RECOMMENDATION

1. In future meetings, each contractor should present examples of graphic reports used to interpret PERT outputs.

2. SP should provide overall FBM Weapons System PERT network as a basis for tie-in for contractor component networks.

3. PERT networks should be developed in sufficient detail to permit timely analysis and program control.

4. SP is requested to distribute to contractors Business Week article on PERT system used at Dupont.

5. SP is requested to monitor the compilation of PERT bibliography for distribution to contractors.

6. Elapsed time should be reduced for interval between time of contractor submission of PERT report to receipt of PERT output.

## SUMMARY REPORT OF GROUP THREE

**J. D. Poulsen, AGC,**
**Chairman**

NETWORK DEVELOPMENT

1. Construction of the flow diagram presented some problems.

a. It seems that some contractors early efforts at constructing a flow diagram were under a crash basis resulting in a diagram that does not show the

program as desired. Thus, in reporting, considerable changes and re-vamping of the program are required.

b. Before undertaking the task of constructing a network, personnel concerned should be educated in the terminology of PERT.

c. Line personnel should be consulted in obtaining data for construction of a network.

2. Use of contractual schedules in drawing up a network was discussed.

a. If, in planning the network, the use of a schedule is utilized, then the use of PERT is only as a reporting tool. If, however, the planning is done without the constraint of a schedule, a more realistic picture of the program may be obtained. When using a contractual schedule, the most-likely date tends to fall on the contractual date. This is not always the true picture. Since this does not show realistic problem areas, then re-direction of effort in problem areas may not be obtained.

3. EVENTS.

a. All agreed that a glossary of terms of events be made to guide internal reporting.

b. Careful use of abbreviations should be made to insure correct interpretation of an event.

c. Event should be rigorously defined in initial planning by those responsible for the event, which will be a definite aid in later reporting of this event. People involved should know and define events.

d. In some areas there seems to be an overlapping of an event description and activity description. In other words, the event description describes the activity. This seems to cause some confusion as to whether an activity description is really necessary. In detailed programs, this seemed to give the most trouble.

4. TIME ESTIMATES.

a. Engineers, or those personnel giving time estimates, should be well acquainted with PERT terminology.

b. It must be remembered what is meant by optimistic and pessimistic time in figuring estimates.

c. In discussing most likely time the use of a contractual schedule came into the picture. Time estimates should be made on what actually has been done, rather than on what is hoped to be done.

d. It was the feeling of the group the number of weeks between events should be limited, this can be done by building detail into the program.

5. HAS PERT REALLY PROVEN TO BE AN AID?

a. One contractor is using PERT as the only progress report. By doing this, many other progress reports have been done away with; consequently money and time saved.

b. Used effectively by one contractor in the control of hardware.

c. All agreed that the methodical planning undertaken in the PERT approach was beneficial.

6. AREAS OF IMPROVEMENT.

a. Use of a complete management tool requires detail.

b. PERT should be made to meet the needs of the line organization.

c. The use of PERT in cost and manpower allocation is looked upon with favor as an area to be undertaken.

d. The question was brought up as to the cost of PERT as opposed to other planning programs.

e. Experimental runs would be beneficial to those contractors who do not have their own computers.

f. When making monthly reports, events downstream should be evaluated as well as those falling within the cut-off date.

## PERT TRANSACTION CODES

BACKGROUND

The "network" or "flow plan" and the associated "elapsed time estimates" of an FBM Subsystem are subject to frequent change. The contractor informs the Special Projects Office (SP-12) of these changes by submitting a "Report of Time Interval Estimates and Progress." (See Enclosure 1) Each line entry on this form affects a PERT activity or in some cases a PERT event and is called a transaction. In order that these transactions may be automatically handled by the NORC programs, a system of transaction codes was established. These codes effectively inform the NORC as to the type of transaction (change) required by the subsystem manager. In general they provide for adding, changing, and deleting data in a subsystem event file that contains one event message for each event in the subsystem. Included in the event message are all the immediate predecessors and successors of that event and their associated mean ($t_e$) and variance ($\sigma_{t_e}^2$). For example let us examine a sample subsystem. (Figure 1)

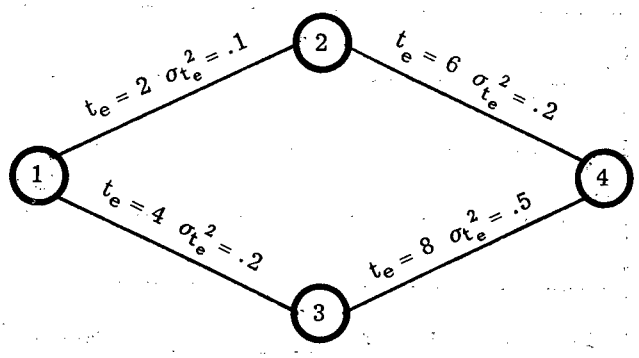



Figure 1

## "PERT"-ACTIVITY ANALYSIS SHEET

FROM_____ TO_____ TIME EST.(wks)_____

EVENT DEFINITION:_____

| BRIEF DESCRIPTION OF WORK DETAIL | Completed | | Time Est. | | |
|---|---|---|---|---|---|
| | Yes | No | Opti-mistic | Likely | Pessi-mistic |
| | | | | | |
| 1. | | | | | |
| | | | | | |
| 2. | | | | | |
| | | | | | |
| 3. | | | | | |
| | | | | | |
| 4. | | | | | |
| | | | | | |
| 5. | | | | | |
| | | | | | |
| 6. | | | | | |
| | | | | | |
| 7. | | | | | |
| | | | | | |
| Info. Rec'd. From_____%complete | | | | | |

ATTACHMENT

The circles represent events; the arrows represent activities. On NORC magnetic tape this subsystem event file, in part, is pictured in figure 2.

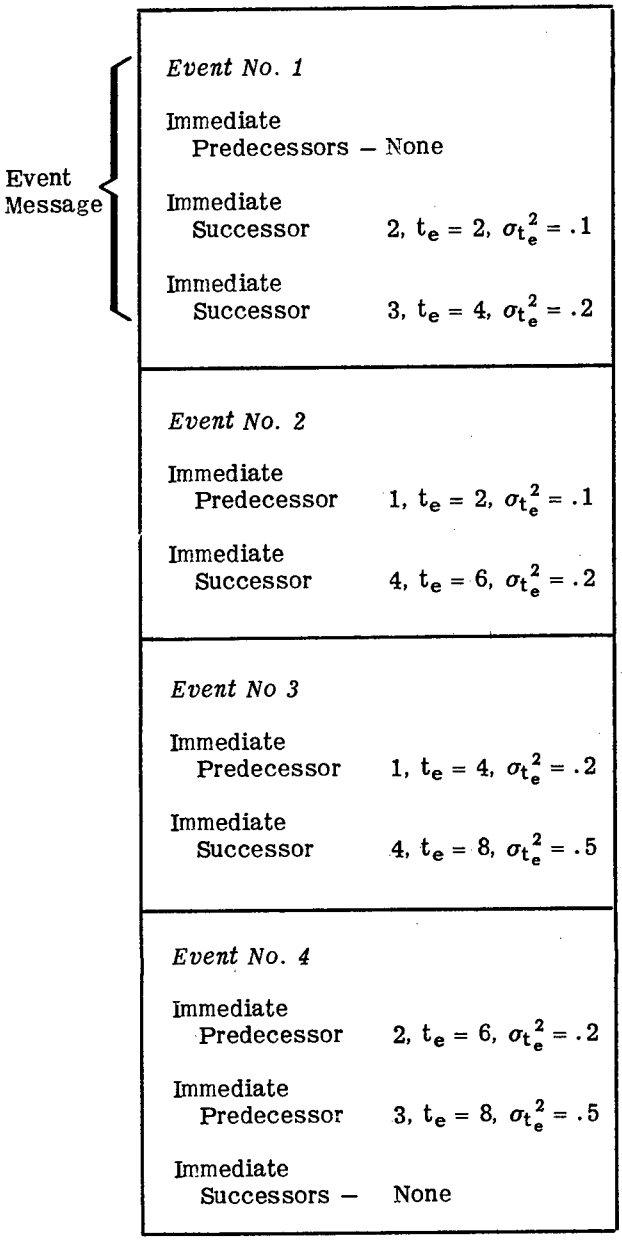



Figure 2

A brief examination of figure 3 reveals that each PERT activity (arrow) appears in the subsystem event file in two places. Because of this, each transaction sent in by the contractor is automatically duplicated by the NORC with one transaction being identified as a predecessor transaction and its duplicate being identified as a successor transaction. The predecessor transaction is used when dealing with the predecessor event; the successor transaction is used when dealing with the sucessor event. It is not shown in figure 3 but there are areas set aside in each event message for a schedule date, a completion date, a short path flag, and a report code.

## DESCRIPTION OF TRANSACTION CODES

(This column notation used below in the description of the Transaction Format, is that found on the form PERT–Report of Time Interval Estimates and Progress.)

NOTE: When referring to an activity (transaction), the "beginning event" is synonymous with the "predecessor event" and the "ending event" is synonymous with the "successor event."

1. Transaction Code 1

a. Purpose. To establish a new activity in a subsystem event file.

b. Transaction Format.

Column A-(1). Enter "1".

Column B. Enter the event code of the beginning event of the activity.

Column C. Enter the event code of the ending event of the activity. Enter in parenthesis, immediately following the event code, the report code, if applicable. The purpose of the report code is described in Transaction Code 8.

Column D. Enter the optimistic elapsed time estimate in weeks and tenths of weeks.

Column E. Enter the most likely elapsed time estimate in weeks and tenths of weeks.

Column F. Enter the pessimistic elapsed time estimate in weeks and tenths of weeks. (Minimum estimate = 000.0, maximum estimate = 999.9)

Column G. Enter the schedule date associated with the ending event of the activity, if applicable. If there is no schedule date, draw a line through the column.

c. Explanation.

If an original file is being set up, this transaction type 1 would construct an event message. If an existent file is being updated, this transaction type 1 would add a new activity to the indicated existent predecessor and successor events or construct and insert a new event message if there are no existent predecessor and/or successor events. If a "schedule date" and/or a "report code" is present, it would be inserted in the successor event message if one were being established. If the successor event has been established, the "schedule date" should be inserted with a 4 code and the "report code" should be inserted with an 8 code.

2. Transaction Code 2

a. Purpose. To re-estimate the elapsed time required for the activity.

b. Transaction Format.

Column A-(1). Enter "2".

Column B. Enter the event code of the beginning event of the activity.

Column C. Enter the event code of the ending event of the activity.

Columns D, E, F, and G. See Transaction Code 1.

c. Explanation.

The new data is used to replace the old in the indicated predecessor and successor event messages. The schedule date, if any, is inserted in the successor event message.

3. Transaction Code 3

a. Purpose. To show that an activity has been completed and to add a completion date to the subsystem event file.

b. Transaction Format.

Column A-(1). Enter "3".

Columns B and C. See Transaction Code 2.

Columns D, E, and F. Enter four zeroes in each column or draw a line through all three columns.

Column G. Enter the completion date associated with the event code in column C.

c. Explanation.

The transaction removes the activity from the indicated events and in the case of the successor event, adds the completion date to the event message. If there is no completion date, the transaction is rejected.

4. Transaction Code 4

a. Purpose. To add a schedule date to the subsystem event file.

b. Transaction Format.

Column A-(1). Enter "4".

Column B. Enter nine zeroes or draw a line through the column.

Column C. Enter the event code of the event message to which the schedule date is to be added.

Columns D, E, and F. See transaction Code 3.

Column G. Enter the schedule date or six zeroes to be associated with the event code entered in column C.

c. Explanation.

If the schedule date on the transaction is zero, then the schedule date area in the event message is made zero. (Effectively this code allows one to insert, change, or delete a schedule date.)

5. Transaction Code 5

a. Purpose. To delete an activity that is in the subsystem event file.

b. Transaction Format.

Column A-(1). Enter "5".

Columns B and C. See transaction Code 2.

Columns D, E, and F. See Transaction Code 3.

Column G. Draw a line through this column.

c. Explanation.

The specified activity is deleted from the beginning and ending event messages.

6. Transaction Code 6

a. Purpose. To add a short path flag to the subsystem event file. In figure 3 are pictured three parallel activities leading to the same event. This could represent the case where three contractors are working independently on the design of a submarine. Event number 4 will be considered accomplished as soon as any one of the submarine designs is complete. Therefore, the subsystem manager may desire the shortest path instead of the longest path leading into event 4. In the normal computations the earliest expected time ($T_E$) for event number 4 would be 5 weeks. If however, there were a short path flag of "1" included in the event number 4 message, the $T_E$ for the event number 4 would be 3 weeks. If a short path flag of "2" were included in the event number 4 message, the computer would compare the computed $T_E$ of 3 weeks with the schedule date for event number 4 and keep the earlier of the two dates for the $T_E$ of event number 4. That is, if the computed $T_E$ of 3 weeks turned out to be 1 August 1960 and the schedule date for event number 4 were 15 July 1960, the computer would assign 15 July 1960 as the earliest expected time for event number 4.

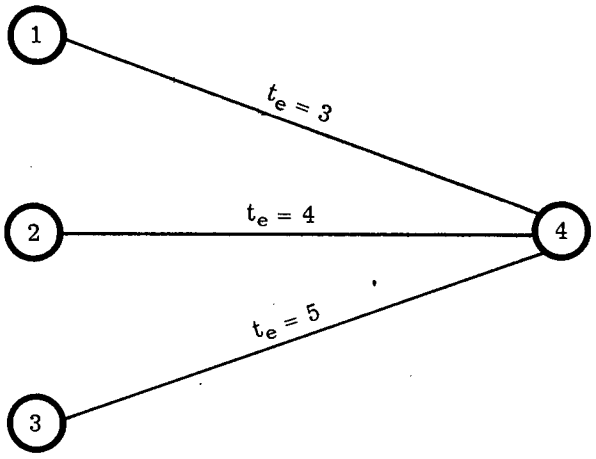



Figure 3

b. Transaction Format.

Column A-(1). Enter "6".

Column A-(4). Enter the short path flag "0", "1", or "2". (See paragraphs 6a and 6c.)

Column B. Enter nine zeroes or draw a line through the column.

Column C. Enter the event code of the event message to which the short path flag is to be added.

Columns D, E, F, and G. Draw a line through these columns.

c. Explanation.

If the short path flag is zero, it will erase the short path flag in the successor event message. If it is "1" or "2", it is inserted in the successor event message, replacing any short path flag that may already be there. If it is "3" or greater, it is changed to a "1" and inserted as stated above.

7. Transaction Code 7

a. Purpose. To add a completion date to any event message in the subsystem event file but especially to starting events. For example, in figure 3 consider events 1, 2, and 3 to be starting events that should have completion dates. Three transactions could be prepared having transaction code 7, the beginning event column having all zeroes, event codes 1, 2, and 3 in the ending event column and showing the proper completion dates for each of the three events.

b. Transaction Format.

Column A-(1). Enter "7".

Column B. Enter nine zeroes or draw a line through the column.

Column C. Enter the event code of the event message to which the completion date is to be added.

Columns D, E, and F. See Transaction Code 3.

Column G. Enter the completion date or six zeroes to be associated with the event code entered in column C.

c. Explanation.

Type 7 is similar to type 3 but differs in that it does not remove an activity from either the predecessor or successor messages. If the completion date on the transaction is zero, then the completion date area in the successor event message is made zero.

8. Transaction Code 8

a. Purpose. To add a report code to any event in the subsystem event file. The report code indicates to the computer that this event and its associated data is to be printed in a special report. For example, if a subsystem manager sould like a report which shows only end point events, he could prepare one transaction for each end point event with transaction code 8, all zeroes in column B, the end point event in column C and a "1" in card column 43 on the transaction form. The computer upon sensing the presence of the report code will segregate those events for special reporting. Digits zero through nine may be used for report codes, thus allowing a maximum of ten different reports on the same subsystem, at the same time.

b. Transaction Format.

Column A-(1). Enter "8".

Column B. Enter nine zeroes or draw a line through the column.

Column C. Enter the event code of the event message to which the report code is to be added. Enter in parenthesis immediately following the event code the report code desired (any digit zero through 9).

Columns D, E, F, and G. Draw a line through these columns.

c. Explanation.

If the report code on the transaction is zero, then the report code area in the successor event message is made zero. (Effectively this code allows one to insert, change, or delete a report code.)

## FLOW CHARTS

Attached are flow charts which show the procedures followed by the computer when processing the PERT transactions.

TRANSACTION CODES - COMPUTER PROCEDURES

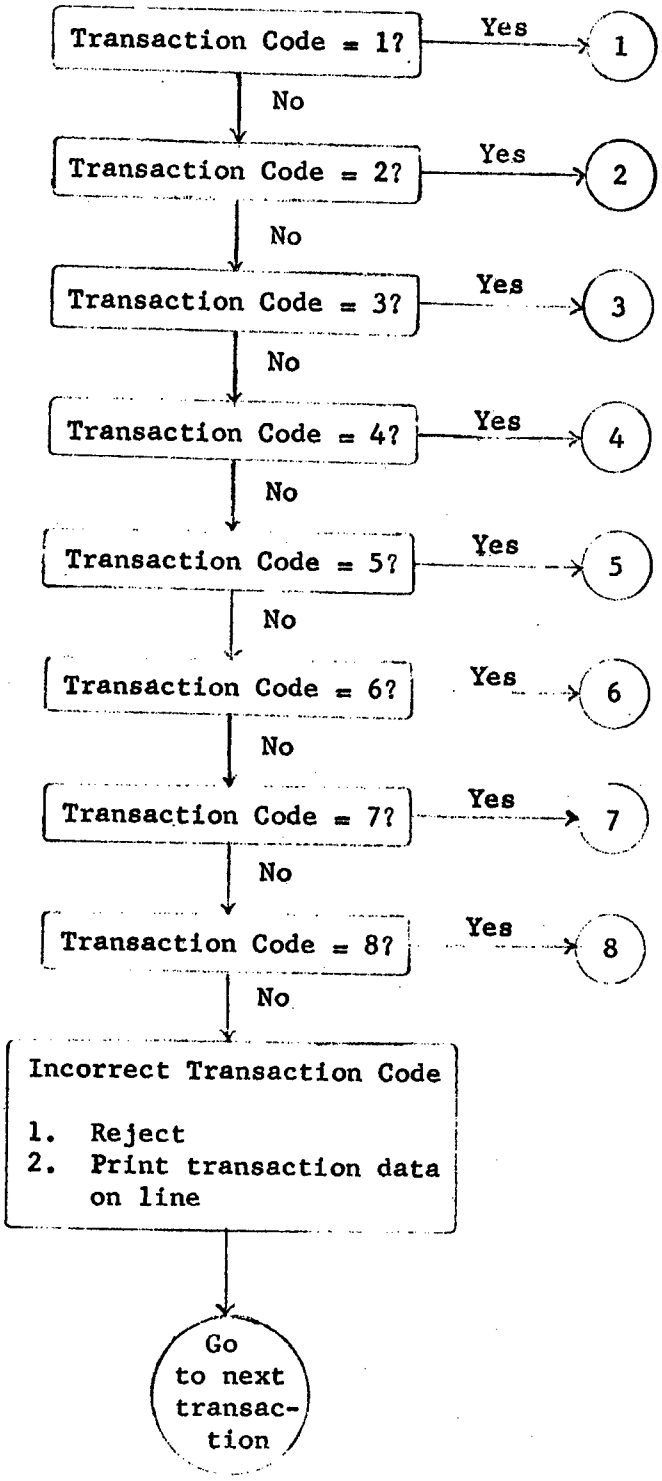



EXHIBIT 1

# TRANSACTION CODE NO. 1 - COMPUTER PROCEDURES

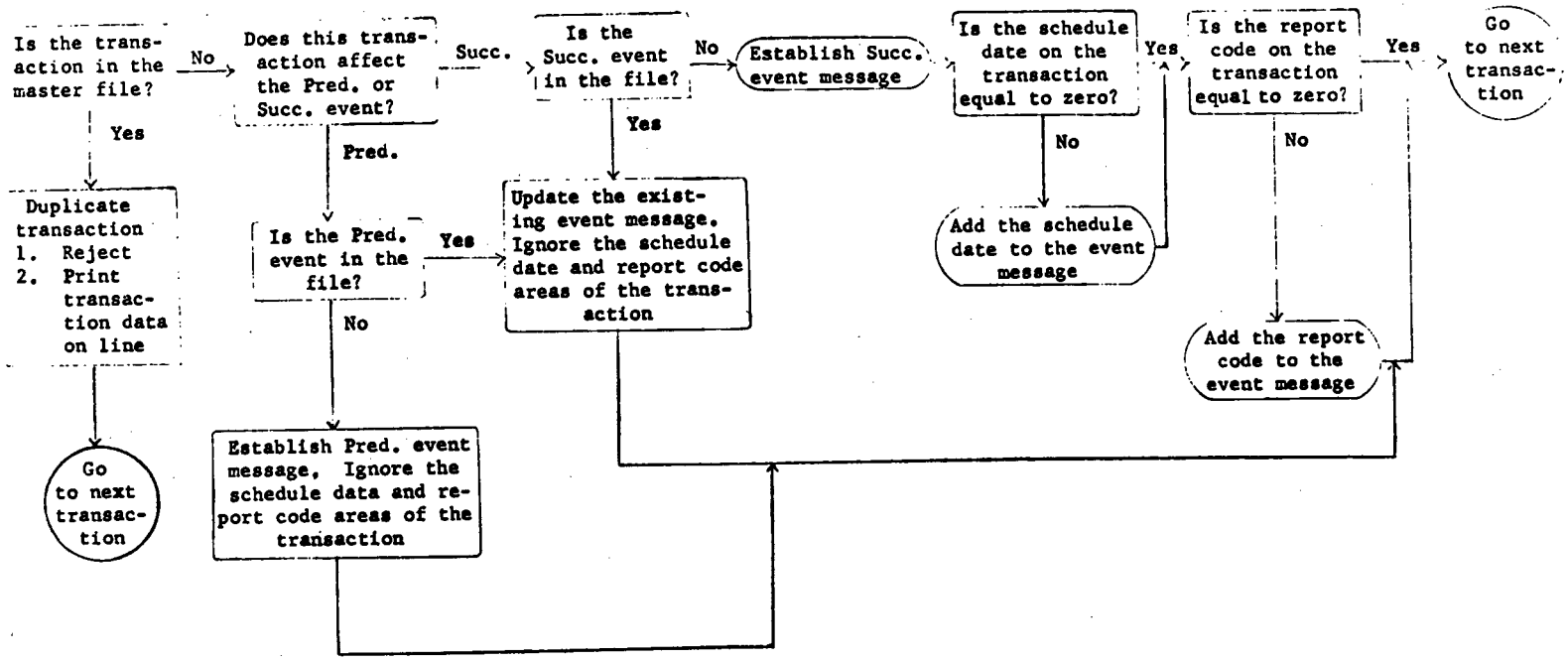



EXHIBIT 2

TRANSACTION CODE NO. 2 - COMPUTER PROCEDURES

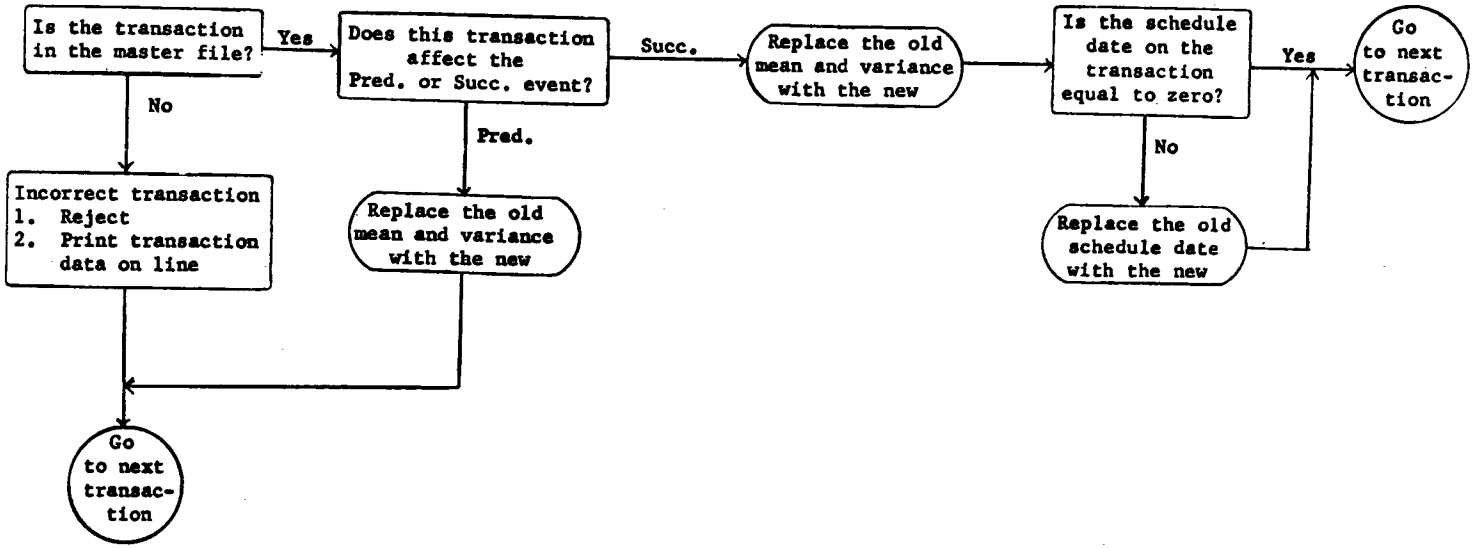



EXHIBIT 3

# TRANSACTION CODE NO. 3 - COMPUTER PROCEDURES

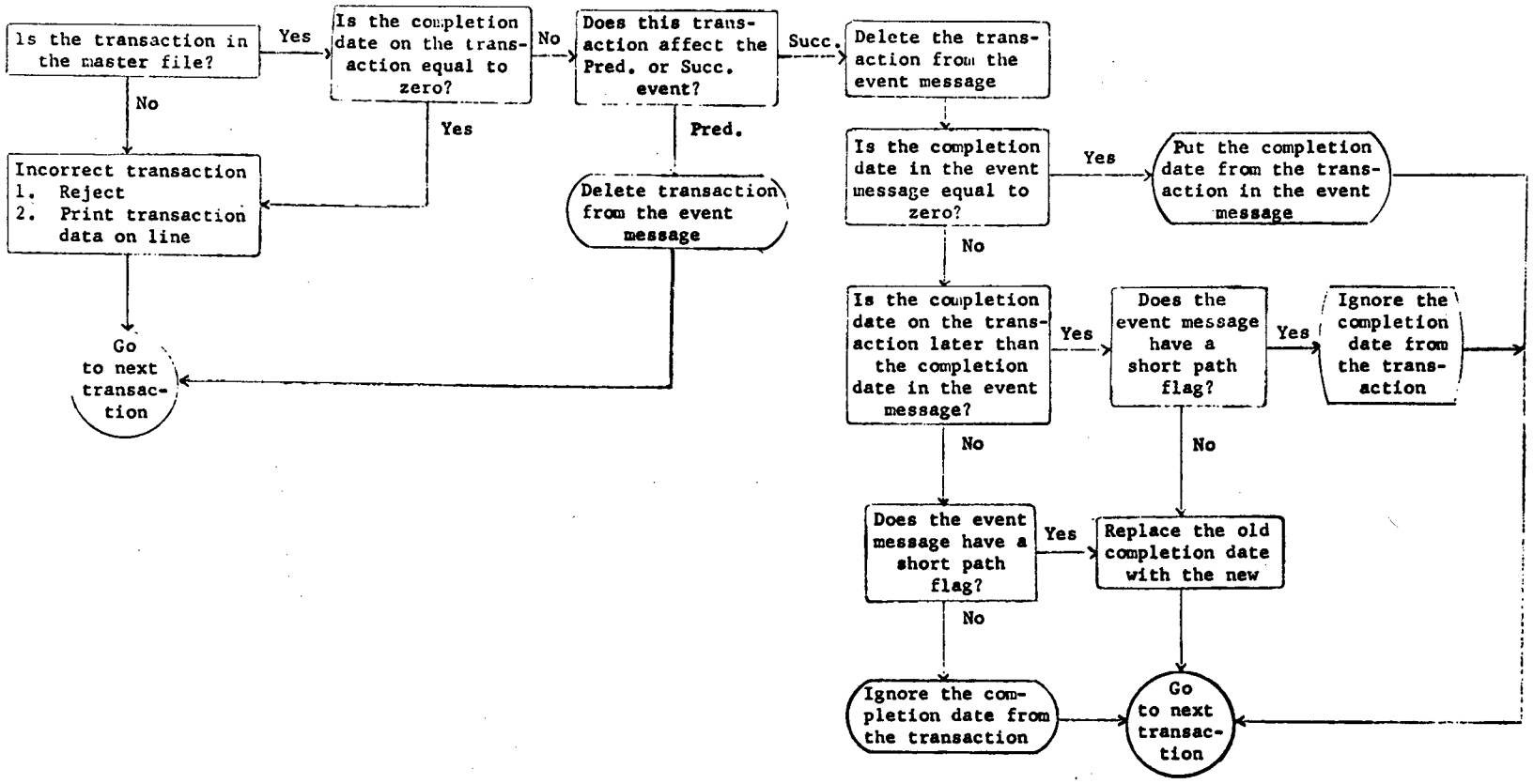



EXHIBIT 4

TRANSACTION CODE NO. 4 - COMPUTER PROCEDURES

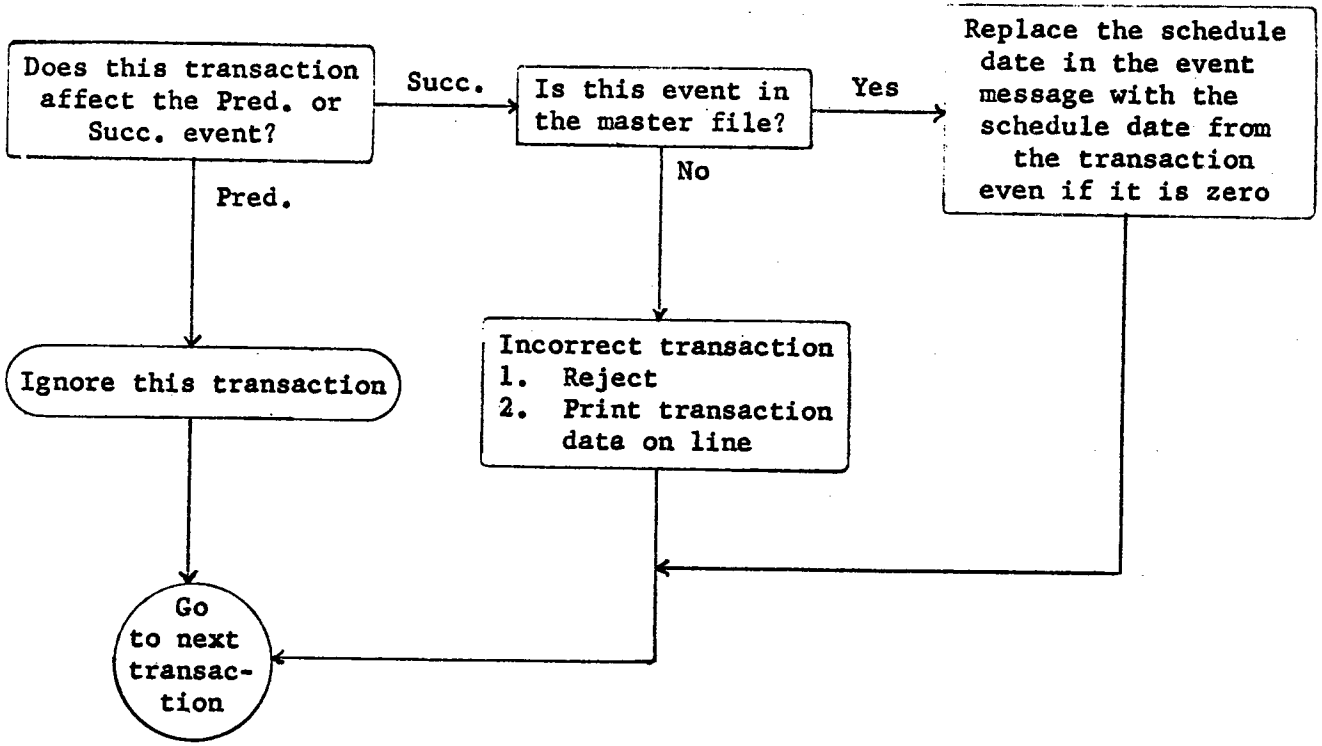



EXHIBIT 5

TRANSACTION CODE NO. 5 - COMPUTER PROCEDURES

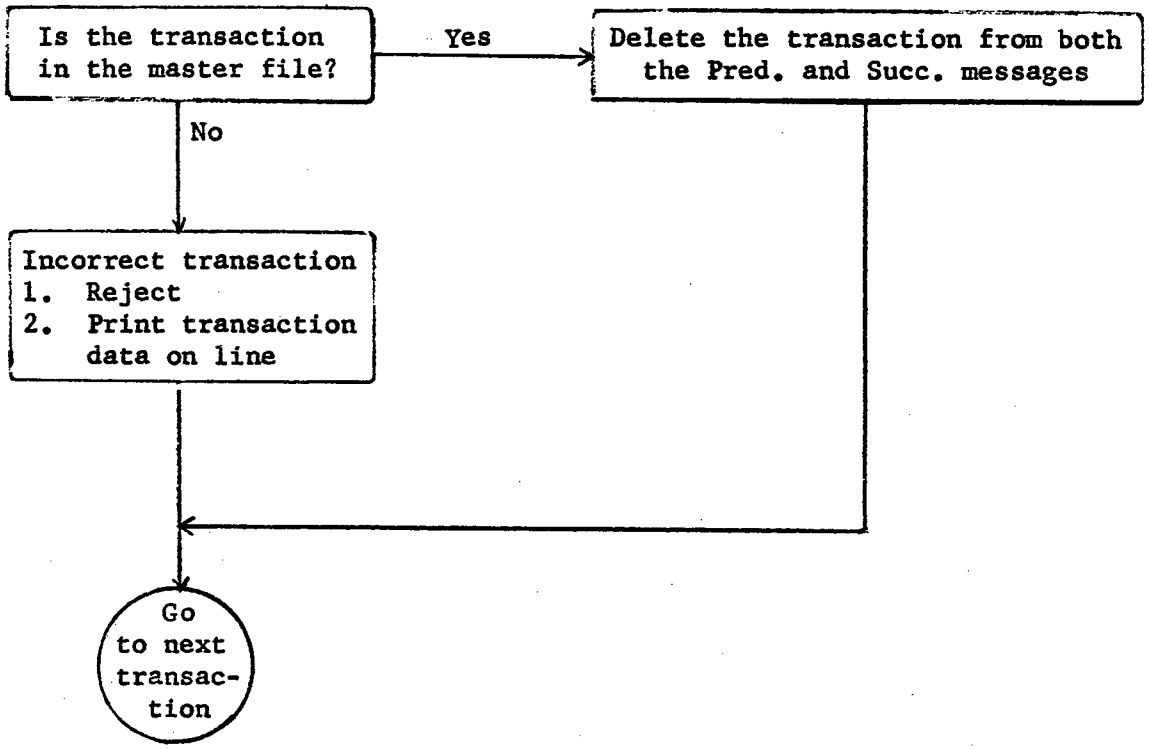



EXHIBIT 6

TRANSACTION CODE NO. 6 - COMPUTER PROCEDURES

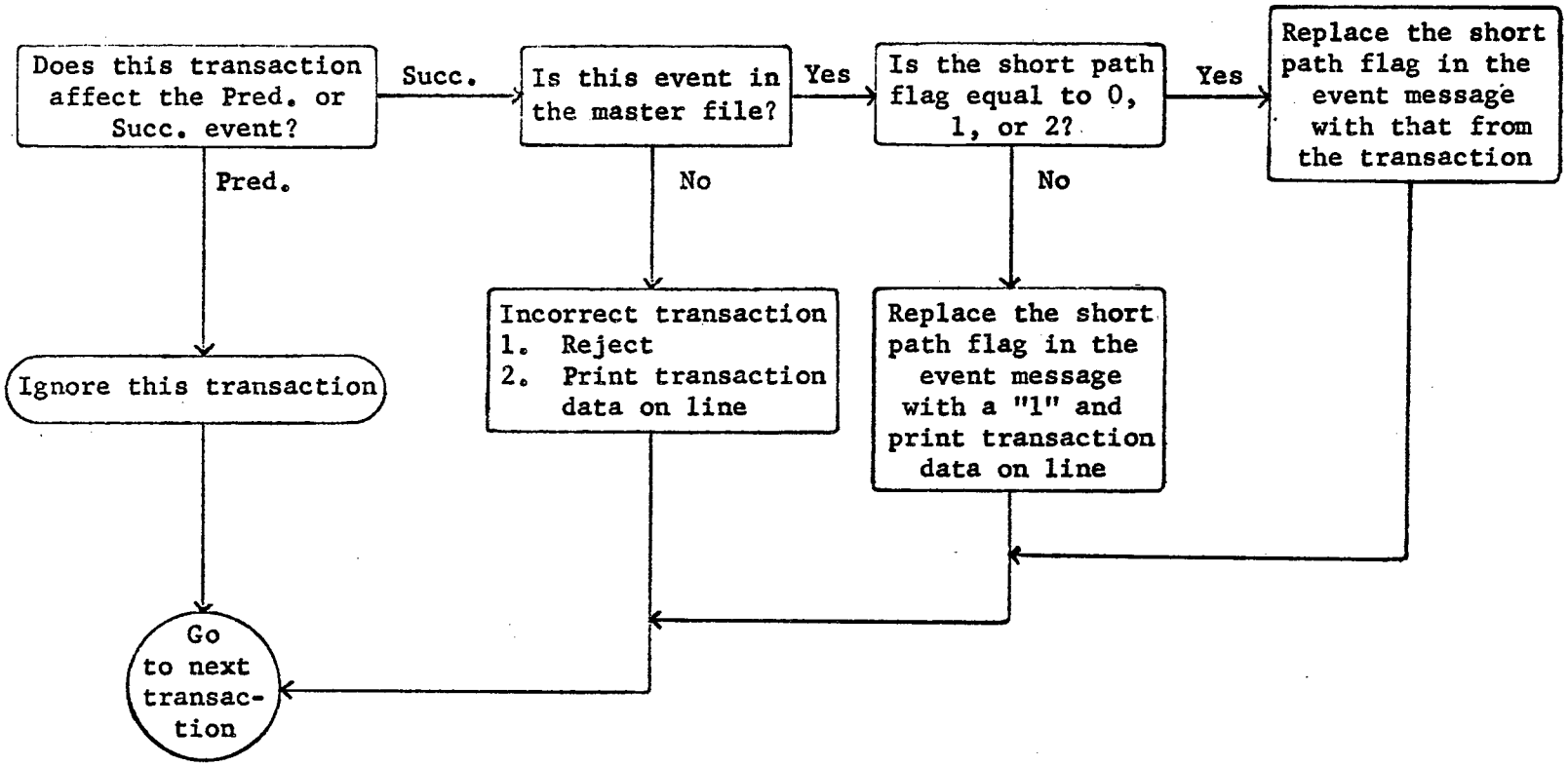



EXHIBIT 7

TRANSACTION CODE NO. 7 - COMPUTER PROCEDURES

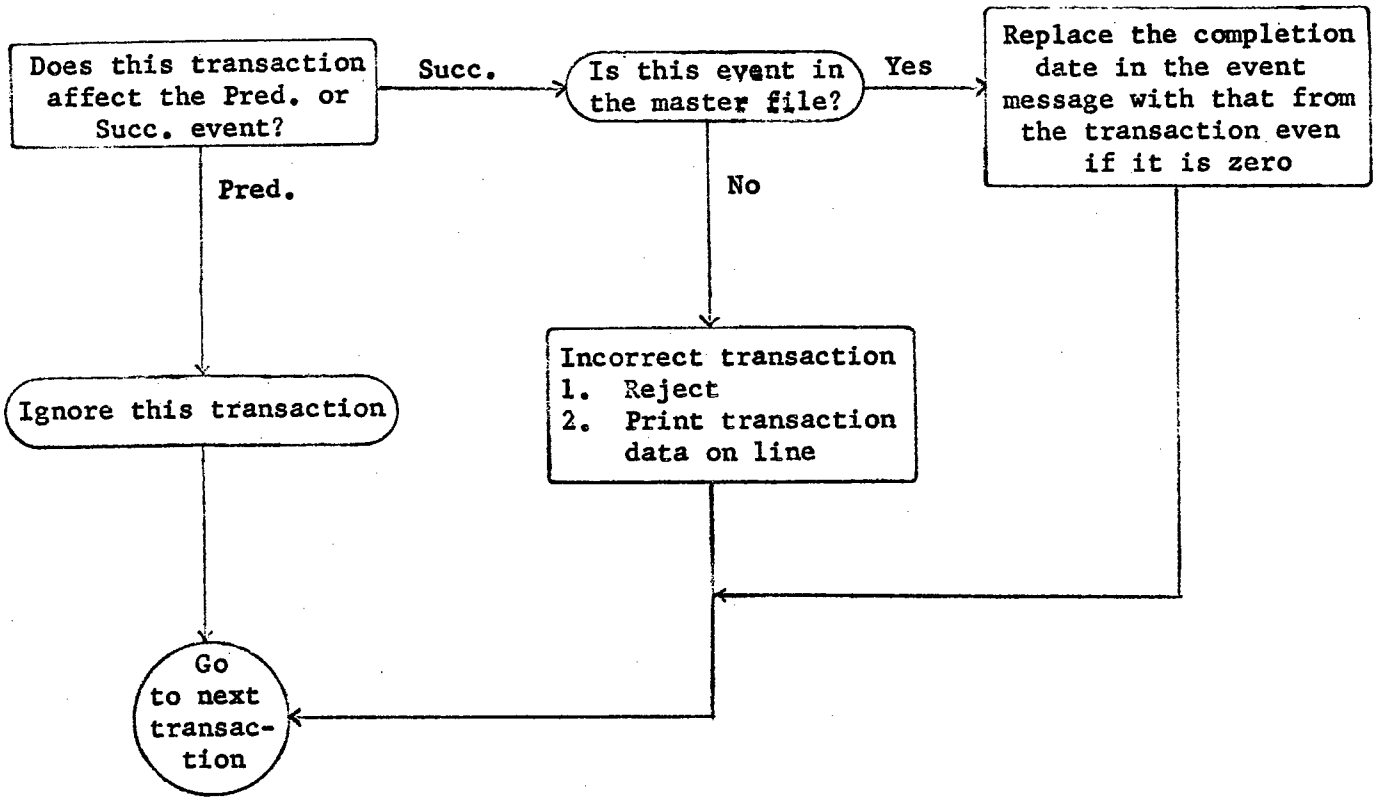



EXHIBIT 8

TRANSACTION CODE NO. 8 - COMPUTER PROCEDURES

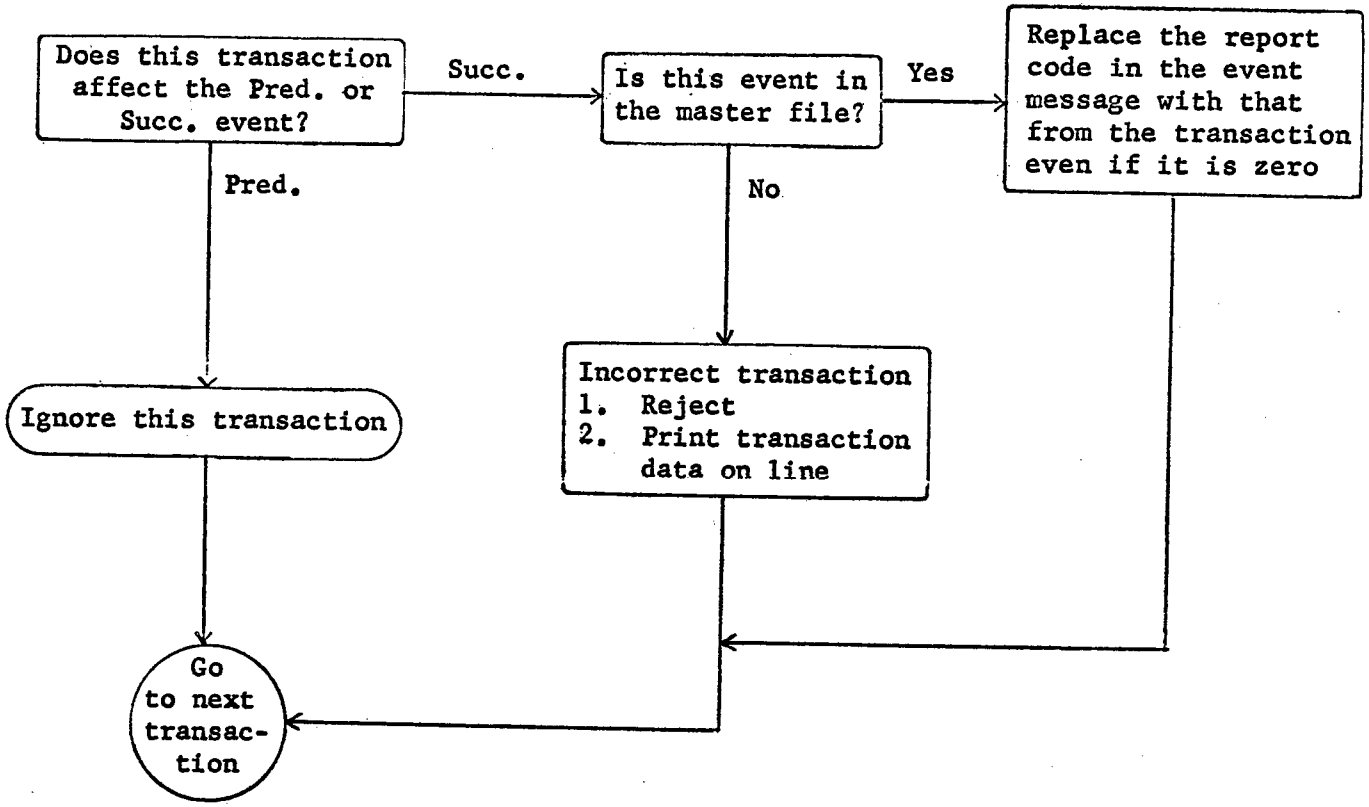



EXHIBIT 9

# SUMMARY MINUTES FOR MEETING OF CONTRACTOR P E R T REPORTING PERSONNEL

8-9 JUNE 1960

GENERAL ELECTRIC
PITTSFIELD, MASSACHUSETTS

# DEPARTMENT OF THE NAVY
## SPECIAL PROJECTS OFFICE
WASHINGTON 25, D.C.

IN REPLY REFER TO

Sp121—YN:vmc
5050
27 June 1960

From: Director Special Projects

To: Distribution

Subject: Meeting of Contractor PERT Reporting Personnel, GE, Pittsfield, Massachusetts, 8 and 9 June 1960.

Enclosures: (1) Sample vugraph of PERT report of time interval estimates and progress.

(2) Summary report of PERT discussion Group No. 1 submitted by George D. Robertson, General Electric.

(3) PERT items discussed by Group No. 2 submitted by Michael Zymaris, Portsmouth Naval Shipyard.

(4) Summary of group meeting at PERT working seminar submitted by Paul Wasserman, Raytheon.

1. Special Projects Office is gratified by the active contractor participation in the subject meeting for furthering the improvement of SP-Contractor program reporting system.

K. M. TEBO
By direction

**ROSTER**
**for**
**Meeting of Contractor PERT Reporting Personnel**
**General Electric, Pittsfield, Massachusetts**
**8 and 9 June 1960**

| | |
|---|---|
| Atomic Energy Commission | W. M. Babb |
| Dunlap & Associates | E. A. Houser, Jr. |
| | D. W. Furman |
| | C. VonWrangell |
| EDO Corporation | A. Bajorski |
| | W. Konrad |
| Electric Boat | J. R. Salzer |
| | C. Sharpe |
| General Electric | A. Bogdan, K. Brown, B. Flood, R. Halligan, K. Knutson, J. McGuire, D. Moss, B. Nalven, L. Neff, W. O'Donnell, A. E. O'Kane, G. Robertson, P. Sanford, C. Sears, J. Valiasek, P. Wallace, R. Morehouse |
| Massachusetts Institute of Tech. | I. Halzel |
| S. Gunner Myrbeck & Company | C. F. Kuhns |
| Naval Weapons Laboratory | R. Learn |
| Nortronics | K. A. Donaghey |
| Portsmouth Naval Shipyard | T. J. Walsh |
| | M. Zymaris |
| Raytheon | R. Froncello |
| | P. Wasserman |
| RCA | C. Dunaief |
| | T. A. Nupp |
| Special Projects Office | Capt. K. M. Tebo, USN |
| | V. Coffey |
| | J. McNicholas |
| | Y. Nakayama |
| | M. Perna |
| SPG | Cdr. R. G. May, USN |
| SPOTR | S. A. Cariske |
| Sperry Marine | W. R. Andersen |
| | K. Williams |
| Sperry Gyroscope | C. Mirrione |
| Sylvania | C. H. Fink |
| | A. G. Lieb |
| USNUSL | C. R. Dorsey |

**SUMMARY MINUTES**
**for**
**Meeting of Contractor PERT Reporting Personnel**
**General Electric, Pittsfield, Massachusetts**
**8 and 9 June 1960**

Captain K. M. Tebo, SP12, welcomed the participants and announced the purpose of the meeting which was to obtain a better working knowledge of the PERT system and improve communication between SP and the contractors. Mr. Yukio Nakayama of SP12 was introduced as the chairman of the meeting who proceeded to introduce the speakers.

Mr. Michael Perna, SP12, discussed the following subjects:

I. DEVELOPMENT OF A NETWORK

1. To draw up the network, it is preferable to start with the end item or delivery of the component and work backwards to the present or beginning of the project.

2. Time scales should not be used.

II. SEQUENCING OF EVENTS

1. Events should be sequenced according to technical requirements.

2. Events should be sequenced in accordance with the currently approved plan. PERT is a means of evaluating current planning.

III. NUMBER OF EVENTS

1. A sufficient number of events should be included to permit timely appraisal of progress.

2. Generally, the length of time interval estimates is a clue to sufficiency in number of events.

3. A greater number of events may be required for the contractor's internal control purpose.

IV. ACTIVITIES

1. Activities, shown as arrows, represent work or effort required between two events.

2. Activities and events must be precisely defined.

V. COMMON EVENTS

1. Each network should have common events with other networks for integrating the interacting influence for achieving the over all FBM capability.

VI. TYPICAL FAILINGS IN NETWORK DEVELOPMENT ARE AS FOLLOWS:

1. Failure to include important activities or events.

2. Leaving events dangling, unconnected, no schedule dates on key events.

3. Closed-cycle connection of events.

4. Using hazy terminology or changing terminology without recording the change in the PERT system.

VII. ELAPSED TIME ESTIMATES

1. The three time estimates should be based on elapsed calendar time in accordance with planned resource application rather than on work days.

VIII. SP REVIEW OF NETWORK

1. Networks are mutually agreed upon between SP and the contractors. Time estimates are reviewed for reasonableness in SP before computer processing.

IX. ANALYSIS AND EVALUATION OF COMPUTER OUTPUTS

1. The critical path or longest path should be reviewed for possible reallocation of resources. A complete review may also point up a need for a change in performance specifications.

X. REPORTING AND COMPUTER OPERATIONS

1. Computer simulation runs will provide a means of evaluating current plans and for arriving at decisions for alternate courses of action.

2. The bi-weekly contractor reports are means of maintaining continuous review of adjustments to plans.

3. PERT provides a common plan which is rapidly updated for SP and contractor management.

Miss Vera Coffey's presentation concerned the following:

I. PERT INPUT CYCLE–FUNCTIONS PERFORMED IN SP 12:

1. Receipt of input from contractor in SP office.

2. Update chart with input information.

3. Check previous time sort through and including the end date of the report to determine that those events which are due have been reported complete or reestimated.

4: Send input to the computer.

5. Receipt of output from the computer.

6. Verify data received to determine input and operation validity.

7. Direct NWL to release output sheets to contractors and SP field representatives.

8. Prepare analysis and send it to the contractor and SP field representatives.

II. PERT INPUT FORM (VUGRAPH) *

Line #1 – Inconsistent with flow chart number–1st three digits.
Line #2 – Inconsistent with flow chart number–2nd three digits.
Line #3 – Most likely time must have the same or a greater estimate than the optimistic time.
Line #4 – Assuming that 001.0, 002.0, 003.0 was a re-estimate then is the 05/16/60 date intended to be a reschedule date or a completion date since the report is as of 05/26/60?
Line #5 – 05/27/60 is one day greater than the report date of 05/26/60. Is this intended as a completion or a reschedule date?
Line #6 – Activity reported for deletion without connection to other events in the network.
Line #7 – Only the ending event is necessary when establishing a schedule date.
Line #8 – In entering or deleting a schedule date with Code 4; time interval estimates need not be reported. To delete a schedule date enter Code 4 in Column (A)(1) and 00/00/00 in Column G.
Line #9 – Time estimates for the activity are the same as on a prior input.
Lines #10-11 – Two schedule dates with same month and day listed with different years.
Line #12 – Code 7 is used for establishing base line for new networks.

1. An arbitrary base line can be established with a completion date.

2. An actual completion date can be entered for a predecessor event as a starting point for a successor.

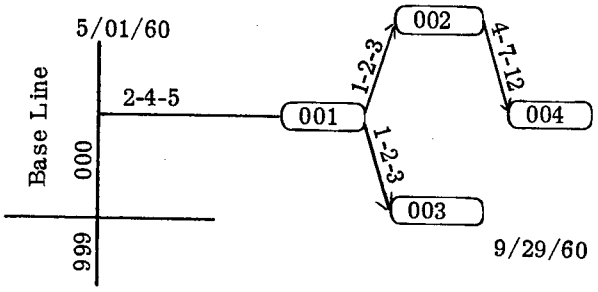
* (See Exhibit 1)

REMARKS COLUMN: It was suggested that contractors give a brief explanation of transactions which are entered on the inputs. An explanation for events or activities due for completion during report period but not completed, reason for slippage and contractor action should be included.

III. TE SORT (VUGRAPH)

1. Check expected date column of the Te sort down through and including the ending date of the report to determine whether each event with an expected date before or on the ending report date has been included in the current report.

IV. SAMPLE PERT NETWORK




1. A single base line may have a maximum of 32 activities leading from it. Should more than 32 activities from the base line exist, another number such as 999 may be chosen for a second but identical base line, and 32 activities may be led from that event.

2. All preceeding events must be complete before an activity leading from one event to another event may be reported complete. Example: 000 to 001 must be complete before 001 to 002 may be reported complete.

3. If the activity from 003 to 004 is deleted, 003 must either have a schedule date on it or be connected to another event. The end event should have a schedule date.

V. NOMENCLATURE

1. Nomenclature should be submitted each time a change is made in the event title.

2. Use an A code when adding or correcting the nomenclature for an event.

3. 48 spaces is the maximum number for nomenclature.

## VI. RECOMMENDATIONS

1. It is recommended that the contractor fill in the transaction code number on the input report. Accordingly, delete the Column A heading, "for office use only," on the PERT time interval report.

2. The remarks column should be used to explain the reason for each transaction.

Mr. Bob Learn of the Naval Weapons Laboratory reviewed the PERT computer program sequence and the operation at NORC.

The 22 questions passed out by the chairman at the end of the meeting became the starting point for the discussion group sessions in the afternoon.

Mr. Charles VanWrangell, Dunlap and Associates, made a presentation on the PERT reporting form. The following suggestions were presented:

1. Reducing the size of the form from 9x12 to 8½x11 inches.

2. Check list for completing the form.

3. Revising the instruction sequence on the form.

Mr. Nakayama discussed the following recommendations, which were made by the discussion groups, on the following day:

GROUP I

RECOMMENDATION 1: It is requested that the written material now available in SP be updated.

ANSWER: The training manual is now being written by S. Gunner Myrbeck with a scheduled completion date in August. SP12 is updating written material.

RECOMMENDATION 2: Prepare a report to include do's and don'ts such as Miss Coffey covered in her presentation at the meeting on June 8th. Include examples of correct and incorrect input data sheets.

ANSWER: This is being included with this report.

RECOMMENDATION 3: A symposium, such as the one at Sperry, should be held at least two times per year. Symposia may be held more often if SP notes that major changes have been made or should be made in the manner in which the SP PERT program is to be conducted.

ANSWER: The next symposium is planned for sometime in August at LMSD.

RECOMMENDATION 4: It was reported that some SP analysts have required that large positive slacks be falsely removed from the charts in special cases.

ANSWER: The practice of including artificial constraints will be discontinued.

RECOMMENDATION 5: It is recommended that SP encourage contractors to experiment with variations of the basic PERT concept now in use in order to seek improvements and an expansion in the benefits to be derived from use of the technique.

ANSWER: SP policy always has been to encourage contractors to experiment and improve the system. SP invites contractors to come in with proposals for improving the PERT system. We have received a proposal from LMSD on PERTing resources. SP has also brought in consultants such as Dunlap and Associates and S. Gunner Myrbeck to assist both the contractors and SP in improving the PERT system.

RECOMMENDATION 6: A greater use of graphic reports should be made.

ANSWER: At the present time, SP can provide two types of graphic reports, (1) the one year plan and (2) the five year plan. These are bar charts which are automatically processed through NORC and give comparison of expected time and the schedule dates. These reports can be provided only if we obtain schedule dates from the contractor as a basis for comparison. SP will provide PERT graphic reports to all those who request them. SP is also experimenting with more sophisticated graphic reports.

GROUP II

RECOMMENDATION 7: It is requested that SP send a questionnaire to the contractors on the following:

1. Who in the contractor organization should submit bi-weekly reports?
2. To whom are questions on bi-weekly reports ordinarily referred?
3. Who in the reporting activity should be the recipient of computer outputs?
4. To whom should comments (analysis report) by SP12 and BUSHIPS be forwarded for review and possible action?

ANSWER: SP will send out a questionnaire to each contractor.

RECOMMENDATION 8: Define resource application.

ANSWER: Resource application is the planned utilization of manpower, material and facilities for the accomplishment of an activity in the PERT network. The work to be performed and the planned resource application is the basis for the three time estimates. As a result, basis for time estimates may vary from activity to activity in accordance with planned resource utilization.

GROUP III

RECOMMENDATION 9: Assistance from SP should be given on activities to be performed by the Bureau.

ANSWER: This matter is now being taken care of by SP12 coordination and the SP technical branch dealing with the contractor. SP12 is in the process of systemizing a procedure for obtaining SP inputs.

RECOMMENDATION 10: Are computer output sheets being revised?

ANSWER: SP is now in the process of obtaining event and activity oriented output sheets. The activity output sheets should be available in August from NORC and will be made available to the contractor.

RECOMMENDATION 11: SP encourages contractor use of NORC for simulation runs to improve planning.

The meeting was adjourned at 12:15 on Thursday, June 9, 1960.

## SUMMARY REPORT OF PERT DISCUSSION GROUP NO. 1

### June 8, 1960

BASE LINE

The *Base Line is a starting point.* It may be thought of as a line or a box. It is just another event, the first event in the network.

As the NORC computer is now programmed for PERT, the base line must not be at a future time. The base line must be dated at present time or some time in the past.

The group concluded that the program need not have this restriction. Perhaps it would be more convenient to have a base line at some future time if you are using PERT as a planning tool during a proposal effort. I don't think anyone felt that the present limitation is a serious one. It is relatively easily circumvented.

For example, let us suppose that the first event in the network is not expected to occur until 26 weeks in the future. You could select the present date as the base line and make the activity time between the base line and the first network event 26, 26, 26 weeks long.

Another programming detail that was brought out is that some existing computer programs *retain the base line* in the computer memory file indefinitely. Other programs in use retain the base line and other events back only as far as the last completed event in each path. All other completed events are automatically dropped from the memory. This is a programming detail which has no effect on the standard report from the computer.

BASIS FOR ESTIMATING

There was considerable discussion on the basis for estimating activity time. Should you factor in holidays, when they occur, the availability of John Doe who can do the job in 1/6 the time of anyone else, use of a 40 hour or a 70 hour week, etc.?

I believe the majority opinion was that the initial estimates should be based on the assumption that the normally available or expected resources will remain constant throughout the period of the program. This should result in a best average estimate based on normal working conditions expected during the period of time in which the program is to be performed.

A suggested ground rule was to estimate the activity time on the assumption that the activity will be on the critical path. The theory here is that you should then get an estimate with no gravy in it.

The majority feeling was that you should first ask the engineers or functional managers for their estimates independent of calendar time of the activities. Then after the first computer run on the network, go back and re-estimate to factor in such things as holidays and resource availability in the time period during which the activities are then expected to occur.

Two techniques were reported for preventing the estimators from thinking in terms of calendar dates. Using either technique, first establish the PERT network complete less all activity time estimates.

TECHNIQUE 1

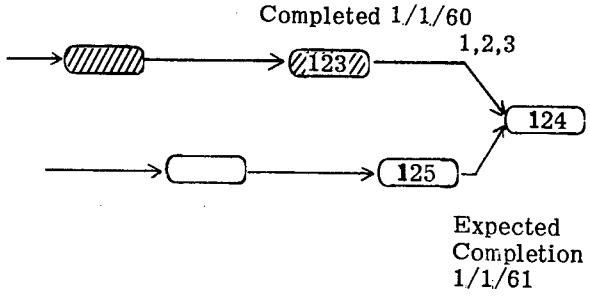
Call all estimators into a room. *Do not* start at the base line and proceed through the network in obtaining estimates. Start somewhere in the middle of the network and skip around until the complete network of activities have finally been estimated. In this way it becomes difficult or impossible for the estimators to factor calendar dates into their estimates.

TECHNIQUE 2

Cut the network into a number of pieces and obtain estimates for the small sub-networks thus generated. Then put the pieces back together to form the overall network.

HIGH POSITIVE SLACK EVENT

It is reported that some SP analysts have required that large positive slacks be falsely removed from the charts in special cases. The case in point is one where an event has been completed say one year before it is needed to complete the next event in the network.



In the example, event 123 has been completed but event 124 is not expected to be completed until one year later due to difficulties encountered in completing event 125.

Reportedly in such a case, certain analysts have required that the activity time between 123 and 124 be changed to something like 52, 52, 52. This was to make the path a zero slack path rather than a +50 weeks slack path.

The group wishes to go on record as in disagreement with such a practice. Miss Coffey has agreed to investigate..

SUMMARY PERT CHARTS

It was brought out in the discussion that many contractors are using, or they are planning to use, summary charts where very large networks are involved. These summary charts consist of selected major events in the complete detailed network. Such networks are helpful to higher levels of management in reviewing the status of a large program.

The summary chart may also be used as the initial program network which is later expanded into a more detailed network.

RECOMMENDATIONS TO SP FOR TRAINING PERT PERSONNEL

(1) Update written material now available in SP.

(2) Include do's and don'ts such as Miss Coffey covered in her presentation at the meeting on June 8th. Include examples of correct and incorrect input data sheets.

(3) Have symposia such as the one at Sperry at least two times per year. Hold symposia more often if SP notes that major changes have been made or should be made in the manner in which the SP PERT program is to be conducted.

RESEARCH

It is recommended that SP encourage contractors to experiment with variations of the basic PERT concept now in use in order to seek improvements and an expansion in the benefits to be derived from use of the technique.

Respectively submitted,

George D. Robertson
Ordnance Department
General Electric Company

June 10, 1960

## PERT
### Items Discussed by Group No. 2

1. The advantages of a graphical PERT output would make it an excellent device for informing schedulers and management. It seemed to be the consensus of opinion that extensive use was not being made of this presentation.

(Note: A graphic report can only be generated after a schedule date is attached to a particular event.)

Mr. McNicholas of SP stated that computer results are checked by SP12. This review includes error analysis; any glaring discrepancies are called to the attention of the reporting activity.

At this point the following questions were raised:

1. Who in the contractor organization should submit bi-weekly reports?
2. To whom are questions on bi-weekly reports ordinarily referred?
3. Who in the reporting activity should be the recipient of computer outputs?
4. To whom should comments (Analysis report) by SP12 and BUSHIPS be forwarded for review and possible action?

When assigning titles to events, particular care should be exercised to assure that event numbers are not repeated because this would shorten the computer network.

Mr. Nakayama, please define resource application.

Unanimously agreed that:

1. A pamphlet or booklet be composed that would outline a simplified method of reporting. This could include typical problems, alternate methods of reporting changes, etc.
2. Comments from all discussion groups be collected, printed, and distributed to attendees.

Michael Zymaris
Portsmouth Naval Shipyard
Portsmouth, New Hampshire

10 June 1960

TO: Miss Vera Coffey
c/o Capt K. Tebo
BuWEPS
Munitions Building
Constitution Avenue
Washington, D. C.

SUBJECT: Summary of Group Meeting at PERT Working Seminar on 8 June 1960
A. E. O'Kane — Chairman

A group meeting was held in the Engineering Conference Room where many facets of the PERT Reporting System were discussed. The following were the topics and agreements resulting from the meeting:

1. *Assistance from Special Projects on Events to be Performed by the Bureau:*
Events such as, Design Approval, Spares Provisioning, Expenditure Approval for Special Tooling and Equipment, Type Testing of Units, etc. sometimes fall into a minus slack position and can jeopardize the success of the program.
The remarks column of the input sheets can be used to highlight the need for expediting assistance from Special Projects.
It would also be desirable to be able to obtain new estimates on these events directly from Special Projects on a report similar to the input reports that the contractors currently submit.

2. *Reasons for Changes In Time Estimates*
At the outset, networks are structured and calculated on a 40 hour week plan and a "practical build" basis. After the receipt of the first output report, the time estimates on "critical slack" items can be changed by:
Introduction of new resources such as, reassignment of personnel from other programs.
Addition of multiple shift activity.
Reassignment of program personnel from tasks on "plus slack" items to the critical path areas.
Changes in processing sequences after evaluating possibility of additional manufacturing cost vs importance of regaining schedule position.
Decisions to extend the normal work week upon approval by customer.
All of the above and other reasons should be briefly explained in the remarks column to clarify the changes and effect a smoother flow in submission and processing of reports.

3. *Activity Completions Reported Out of Sequence*
An example of this type of occurrence would be:
A unit may be completely built except for one or two items that are short. It may be inspected and tested without these components and the balance of inspection and assembly can be completed after the test cycle, thereby gainfully employing the time which would otherwise be spent awaiting completion of the material procurement.
This type of reported activity should necessitate a change in the array on the network or the introduction of a new activity to prevent misunderstanding at the Special Projects Office.
The network for the next system will have to be modified back to its original state if this condition does not occur on the subsequent systems.

4. *Use of PERT Network for High Rate Production Programs*
The network is set up to cover the first months production and shipment.
Blocks of events representing a regular months production quantity can be portrayed on the Network. Activities and events that are completed for the contractual run such as, Engineering Release, Requisitioning, Tooling, Processing, and Test Equipment, etc. will not require modification, but each manufacturing cycle item will require re-estimating to reflect completion of learning curves, development of manufacturing techniques, etc.

5. *Schedule Change Decisions Caused by Special Projects Coverage*
Special Projects maintains cognizance of contractors' in plant schedule status for each program end item and the relative bearing its indicated delivery promise has on the overall FBM Program.
A behind schedule position may exist at one contractor plant necessitating the expending of premium time. At the same time technical problems at another contractor's plant may cause an insurmountable delay to an end item which is required prior to the item being manufactured on premium time.

Special Projects may then ask for a re-evaluation and decision to be made as to the necessity of continuing premium effort at the contractor plant without essential gain to the overall program.

6. *Review of Network Time Estimates by Management Personnel Prior to Submission to Special Projects*

Personnel making up the estimates shall consist of employees who have a full knowledge of the needed resources and can also perform the reported activity.

Line Supervisory management personnel should make calculations to insure that the time estimates are reasonable and the sequencing of steps are correct. The network should be spot checked manually and may cause re-evaluations as to the array of steps and time interval estimates thereby reducing minus slack times wherever possible, prior to submitting the first report.

7. *Definition of Critical Paths*

On the first output report received from the Computer Center, the critical path is the longest time cycle of activities and events or those items with the largest "minus Slack" time. Other critical paths may be set up and take priority over the original path when the possibility of failures in the performance of controlling activities become known at the contractor's plant.

8. *Events Reported Completed that Revert Back to an Incomplete Position*

An event can be reported complete, but technical problems may cause the unit to be taken out of its completed position for problem solution and major rework. The practical method for handling this type of situation is to insert the new activities into the array to bridge the gap between the complete and incomplete events.

If these technical problems have been solved prior to the production of the next contractual quantity, then the new activities must be eliminated in their applicable array in subsequent input reports. The insertion and deletion of the above activities should be coded and adequately explained in the remarks column of the input report.

9. *Review of Sample Output Reports*

For the benefit of the members who are in the early stages of implementation of the PERT System, sample output reports were distributed by Y. Nakayama for illustration and discussion. This effected clarification and was extremely helpful in indoctrinating the members to whom the PERT System is relatively new.

The discussions within the group were highly successful and many areas in question were clarified. There was an extremely high level of interest in the PERT System and its use as a valuable tool for both the customer and contractor management personnel.

P. WASSERMAN
Manager of Production Control

PW/jc

Page_____

PERT
REPORT OF TIME INTERVAL
ESTIMATES & PROGRESS

CLASSIFICATION:

Form Approved
Budget Bureau No. 45-R297
Expires 31 December 1961

From: (Name & Location of Contractor)

To: Special Projects Office (SP12)
Department of the Navy
Washington 25, D. C.

Flow Chart No. 019-200

Contract No.

Report Period
From: 12 May 1960
To : 26 May 1960

| For office use only (A) (1) (2) (3) (4) | Activity Identification | | Time Interval Estimates | | | Completion Date | | | Remarks (See Instructions, over) |
|---|---|---|---|---|---|---|---|---|---|
| | Beginning Event No. (B) | Ending Event No. (C) | Optimistic (weeks) * (D) | Most Likely (weeks) * (E) | Pessimistic (weeks) * (F) | Mo. (G) | Day (G) | Yr. (G) | (H) |
| 12 | 13-16 | 17 | 18 - 26 | 34 - 42 | 44 - 47 | 48 - 51 | 52 - 55 | 60 - 65 | |
| 1 | | | 019-200-376 | 020-200-378 | 000.1 | 002.0 | 003.0 | | | |
| 2 | | | 019-200-376 | 019-201-378 | 000.1 | 002.0 | 003.0 | | | |
| 2 | | | 019-200-376 | 019-200-378 | 001.0 | 000.2 | 003.0 | | | |
| 2 | 3 | | 019-200-376 | 019-200-378 | 001.0 | 002.0 | 003.0 | 05 | 16 | 60 |
| 3 | 4 | | 019-200-376 | 019-200-378 | | | | 05 | 27 | 60 |
| 5 | | | 019-200-376 | 019-200-378 | | | | | | |
| 4 | | | 019-200-376 | 019-200-378 | | | | 01 | 20 | 61 |
| 4 | | | | 019-200-378 | 001.0 | 002.0 | 003.0 | 00 01 | 00 20 | 00 61 |
| 2 | | | 019-200-376 | 019-200-378 | 001.0 | 002.0 | 003.0 | | | |
| 1 | 2 | | 019-200-376 | 019-200-378 | 001.0 | 002.0 | 003.0 | 06 | 10 | 60 |
| 1 | 2 | | 019-200-376 | 019-200-378 | 001.0 | 002.0 | 003.0 | 06 | 10 | 61 |
| 7 | | | | 019-200-378 | | | | 05 | 12 | 60 |

Signature of Responsible Official:

Date Signed:

CLASSIFICATION:

EXHIBIT 1

* Columns D, E, and F. These estimates should be given for the full activity even though the activity has already started.